CLAIMS

WE CLAIM:

1. A lens system with application in ellipsometer and polarimeter systems wherein birefringence, and spectroscopic electromagnetic beam spot size chromatic dispersion reduction and focal length chromatic dispersion reduction is desired, but wherein spherical and third order aberations, coma distortion, astigmatism and image reproduction are substantially unimportant considerations, said lens system comprising two sequentially oriented elements, one of said two sequentially oriented elements being of a shape and orientation which individually converges a beam of electromagnetic radiation caused to pass therethrough, and the other being of a shape and orientation which individually diverges a beam of electromagnetic radiation caused to pass therethrough, wherein said convergence effect is greater than said divergence effect; there being a region between said at least two elements such that, in use, a beam of electromagnetic radiation sequentially passes through one of said at least two elements, then said region therebetween, and then the other of said at least two elements before emerging as an effectively converged, focused, beam of electromagnetic radiation.

2. A lens system ~~with~~ application in ellipsometer and polarimeter systems as in Claim 1, wherein said converging element presents as a selection from the group consisting of:

a bi-convex;
a plano-convex with an essentially flat side;

and wherein said diverging element presents as a selection from the group consisting of:

a bi-concave lens element;

a plano-concave with an essentially flat side;

said lens system comprising a selection from the group consisting of:

a) a sequential combination of a bi-convex element and a bi-concave element;

b) a sequential combination of a bi-concave element and a bi-convex element;

c) a sequential combination of a bi-convex element and a plano-concave element with said concave side of said plano-concave element adjacent to said bi-convex element;

d) a sequential combination of a bi-convex element and a plano-concave element with said essentially flat side of said plano-concave element being adjacent to said bi-convex element;

e) a sequential combination of a plano-concave element and a bi-convex element with said essentially flat side of said plano-concave element adjacent to said bi-concave element;

f) a sequential combination of a plano-concave element and bi-convex element with said concave side of said plano-concave element adjacent to said bi-convex element;

g) a sequential combination of a plano-convex element and a bi-concave element with said essentially flat side of said plano-convex element adjacent to said bi-concave

element;

h) a sequential combination of a bi-concave element with a plano-convex element with said convex side of said plano-convex element adjacent to said bi-concave element;

i) a sequential combination of a plano-concave element and a plano-convex element with the essentially flat side of said plano-concave element being adjacent to the convex side of the plano-convex element;

j) a sequential combination of a plano-concve element and a plano-convex element with the essentially flat side of said planoconcave element being adjacent tot he convex side of said plano-convex element;

k) a sequential combination of a plano-convex element and a plano-concave element with the essentially flat side of said plano-covex element and the essentially flat side of said plano-concave element being adjacent to one another;

l) a sequential combination of a plano-concave element and a plano-convex element with the concave side of said plano-concave element being adjacent to the convex side of the plano-convex element;

m) a sequential combination of a plano-convex element and a bi-concave element with said convex side of said plano-convex element adjacent to said bi-concave element;

n) a sequential combination of a bi-concave element and a plano-convex element with said essentially flat side of said plano-convex element adjacent to said bi-concave element;

o) a sequential combination of a plano-convex element and a plano-concave element with said convex side of said plano-convex element adjacent to the concave side of the plano-concave element;

q) a sequential combination of a plano-concave element and a plano-convex element with said essentially flat side of said plano-convex element being adjacent to the essentially flat side of the plano-concave element;

r) a sequential combination of a plano-convex element and a plano-concave element with said convex side of said plano-convex element being adjacent to the essentially flat side of the plano-concave element;

s) a sequential combination of a plano-concave element with a plano-convex element with the essentially flat side of said plano-convex element being adjacent to the concave side of said plano-concave element;

and wherein said region between said at least two elements has essentially the optical properties of a selection from the group consisting of:

a void region; and
a functional equivalent to a void region.

3. A lens system with application in ellipsometer and polarimeter systems as in Claims 1 or 2, wherein each of said at least two elements is made of a material independently selected from the group consisting of:

CaF_2;
BaF_2;
LiF;
MgF_2; and
fused silica;

and wherein each of said at least two elements are individually selected to be made of different materials.

4. A dual stage lens system with application in ellipsometer systems, said dual stage lens system comprising two sequentially oriented lens systems, each of said two sequentially oriented lens systems being comprised of:

at least two sequentially oriented lens elements, one of said at least two sequentially oriented lens elements being of a shape and orientation which individually converges a beam of electromagnetic radiation caused to pass therethrough, and the other being of a shape and orientation which individually diverges a beam of electromagnetic radiation caused to pass therethrough, there being a region between said at least two lens elements such that, in use, a beam of electromagnetic radiation sequentially passes through one of said at least two lens elements, then said region therebetween, and then the other of said at least two lens elements before emerging as a focused beam of electromagnetic radiation; said dual stage lens system comprising at least two sequentially oriented lens elements being a selection from the group consisting of:

a sequential combination of a converging element, a diverging element, a converging element and a diverging element;

a sequential combination of a converging element, a diverging element, a diverging element and a converging element;

a sequential combination of a diverging element, a converging element, a diverging element and a converging element;

a sequential combination of a diverging element, a converging element, a converging element and a diverging element.

5. A dual stage lens system with application in ellipsometer systems as in Claim 4, wherein each said converging element comprises a selection from the group consisting of:

bi-convex;
plano-convex with an essentially flat side;

and wherein each said diverging element comprises a selection from the group consisting of:

a bi-concave;
a plano-concave with an essentially flat side;

each of said two sequentially oriented lenses in said dual stage lens system being described by a selection from the group consisting of:

a) a sequential combination of a bi-convex element and a bi-concave element;

b) a sequential combination of a bi-concave element and a bi-convex element;

c) a sequential combination of a bi-convex element and a plano-concave element with said concave side of said plano-concave element adjacent to said bi-convex element;

d) a sequential combination of a bi-convex element and a plano-concave element with said essentially flat side of said plano-concave element being adjacent to said

bi-convex element;

e) a sequential combination of a plano-concave element and a bi-convex element with said essentially flat side of said plano-concave element adjacent to said bi-concave element;

f) a sequential combination of a plano-concave element and bi-convex element with said concave side of said plano-concave element adjacent to said bi-convex element;

g) a sequential combination of a plano-convex element and a bi-concave element with said essentially flat side of said plano-convex element adjacent to said bi-concave element;

h) a sequential combination of a bi-concave element with a plano-convex element with said convex side of said plano-convex element adjacent to said bi-concave element;

i) a sequential combination of a plano-concave element and a plano-convex element with the essentially flat side of said plano-concave element being adjacent to the convex side of the plano-convex element;

j) a sequential combination of a plano-concve element and a plano-convex element with the essentially flat side of said plano-concave element being adjacent tot he convex side of said plano-convex element;

k) a sequential combination of a plano-convex element and a plano-concave element with the essentially flat side of said plano-covex element and the essentially flat side of said plano-concave element being adjacent to one

another;

l) a sequential combination of a plano-concave element and a plano-convex element with the concave side of said plano-concave element being adjacent to the convex side of the plano-convex element;

m) a sequential combination of a plano-convex element and a bi-concave element with said convex side of said plano-convex element adjacent to said bi-concave element;

n) a sequential combination of a bi-concave element and a plano-convex element with said essentially flat side of said plano-convex element adjacent to said bi-concave element;

o) a sequential combination of a plano-convex element and a plano-concave element with said convex side of said plano-convex element adjacent to the concave side of the plano-concave element;

q) a sequential combination of a plano-concave element and a plano-convex element with said essentially flat side of said plano-convex element being adjacent to the essentially flat side of the plano-concave element;

r) a sequential combination of a plano-convex element and a plano-concave element with said convex side of said plano-convex element being adjacent to the essentially flat side of the plano-concave element;

s) a sequential combination of a plano-concave element with a plano-convex element with the essentially flat side of said plano-convex element being adjacent to the concave side of the of said plano-concave element;

and wherein said region between said first and second elements having essentially the optical properties of a selection from the group consisting of:

a void region; and
a functional equivalent to a void region.

6. A dual stage lens system with application in ellipsometer systems as in Claims 4 or 5, wherein one of said at least two lens elements in each of said two sequentially oriented lenses is made of CaF_2 and the other element in each of said two sequentially oriented lenses is made of fused silica.

7. A dual stage lens system with application in ellipsometer systems as in Claim 4 or 5 or 6, wherein applies at least one selection from the group consisting of:

a. the focal length of the dual stage lens system is between forty and forty-one millimeters over a range of wavelengths of at least two-hundred to seven-hundred nanometers;

b. the focal length of the dual stage lens system varies by less than five (5%) percent over a range of wavelengths of between two-hundred and five-hundred nanometers; and

c. the spot diameter at the focal length of the dual stage lens system is less than seventy-five microns over a range of wavelengths of at least two-hundred to seven-hundred nanometers.

8. An ellipsometer system comprising an input lens system, wherein birefringence, and spectroscopic electromagnetic beam spot size chromatic dispersion reduction and focal length chromatic dispersion reduction is desired, but wherein spherical and third order aberations, coma distortion, astigmatism and

image reproduction are substantially unimportant considerations, said lens system comprising at least two sequentially oriented elements, one of said at least two sequentially oriented elements being of a shape and orientation which individually converges a beam of electromagnetic radiation caused to pass therethrough, and another thereof being of a shape and orientation which individually diverges a beam of electromagnetic radiation caused to pass therethrough, wherein said convergence effect is greater than said divergence effect; there being a region between said two sequentially oriented elements such that, in use, of electromagnetic radiation sequentially passes through one of said elements, then said region therebetween, and then through the other of said two sequentially oriented elements before emerging as an effectively converged, focused, beam of electromagnetic radiation, and wherein at least two elements thereof are made from different materials, such that in use the focal length for each wavelength in a spectroscopic range of wavelengths of electromagnetic radiation caused to pass therethrough is substantially the same as that for every other wavelength.

9. An ellipsometer system comprising an input lens system as in Claim 8, wherein said input lens is selected from the group consisting of:

demonstrating birefringence;
not demonstrating birefringence.

10. An ellipsometer system comprising an input lens system as in Claim 8, characterized by at least one condition selected from the group consisting of:

a. said input lens system comprises at least two sequentially oriented elements, and is characterized by being a selection from the group consisting of:

a sequential combination of a converging element and a diverging element;

a sequential combination of a diverging element and a converging element;

a sequential combination of a converging element, a diverging element, a converging element and a diverging element;

a sequential combination of a converging element, a diverging element, a diverging element and a converging element;

a sequential combination of a diverging element, a converging element, a diverging element and a converging element;

a sequential combination of a diverging element, a converging element, a converging element and a diverging element;

including a miniscus lens; and

including an aspherical lens;

b. said region between at least two of said at least two elements is characterized as a selection from the group consisting of:

a void region; and
a functional equivalent to a void region.

11. An ellipsometer system comprising an input lens system as in Claim 8, wherein one of said at least two sequentially oriented elements in said input lens is made of made of a material selected from the group consisting of:

CaF_2;
BaF_2;
LiF; and
MgF_2;

and another of said at least two sequentially oriented elements in said input lens is made of fused silica.

12. An ellipsometer system sequentially comprising elements selected from the group consisting of:

a. a Source of a spectroscopic beam electromagnetic radiation;
b. a Polarizer element;

in either order elements c. and d.:

c. optionally a compensator element;

d. (additional element(s));

e. a material system;

in either order elements f. and g.:

f. (additional element(s));

g. optionally a compensator element;

h. an Analyzer element; and

i. a Detector System;

in which said additional elements in d. comprise selection(s) from the group consisting of:

beam directing means;
input lens(es); and
window(s);

in which said additional elements in f. comprise selection(s) from the group consisting of:

beam directing means;
output lens(es); and
window(s);

at least one of said input and output lenses, when selected and present, being of multi-element construction, wherein, for said at least one of said input and output lenses at least two elements thereof are made from different materials, such that in use the focal length for each wavelength in a range of wavelengths is essentially the same as that for every other wavelength, wherein said additional elements are selected from the group consisting of:

both demonstrating birefringence;
neither demonstrating birefringence;
one demonstrating birefringence and the other not.

13. An ellipsometer system as in Claim 12, in which at least one of said input and output lens(es) is present and is/are made of two elements, said elements being respectively made of fused silica and (CaF_2); said selected and present input and/or output lens(es) being a configuration selected from the group consisting of:

a) a sequential combination of a bi-convex element and a bi-concave element;

b) a sequential combination of a bi-concave element and a bi-convex element;

c) a sequential combination of a bi-convex element and a plano-concave element with said concave side of said plano-concave element adjacent to said bi-convex element;

d) a sequential combination of a bi-convex element and a plano-concave element with said essentially flat side of said plano-concave element being adjacent to said bi-convex element;

e) a sequential combination of a plano-concave element and a bi-convex element with said essentially flat side of said plano-concave element adjacent to said bi-concave element;

f) a sequential combination of a plano-concave element and bi-convex element with said concave side of said plano-concave element adjacent to said bi-convex element;

g) a sequential combination of a plano-convex element and a bi-concave element with said essentially flat side of said plano-convex element adjacent to said bi-concave element;

h) a sequential combination of a bi-concave element with a plano-convex element with said convex side of said plano-convex element adjacent to said bi-concave element;

i) a sequential combination of a plano-concave element and a plano-convex element with the essentially flat side of said plano-concave element being adjacent to the convex side of the plano-convex element;

j) a sequential combination of a plano-concve element and a plano-convex element with the essentially flat side of said planoconcave element being adjacent tot he convex side of said plano-convex element;

k) a sequential combination of a plano-convex element and a plano-concave element with the essentially flat side of said plano-covex element and the essentially flat side of said plano-concave element being adjacent to one another;

l) a sequential combination of a plano-concave element and a plano-convex element with the concave side of said plano-concave element being adjacent to the convex side of the plano-convex element;

m) a sequential combination of a plano-convex element and a bi-concave element with said convex side of said plano-convex element adjacent to said bi-concave element;

n) a sequential combination of a bi-concave element and a plano-convex element with said essentially flat side of said plano-convex element adjacent to said bi-concave element;

o) a sequential combination of a plano-convex element and a plano-concave element with said convex side of said plano-convex element adjacent to the concave side of the plano-concave element;

q) a sequential combination of a plano-concave element and a plano-convex element with said essentially flat side of said plano-convex element being adjacent to the essentially flat side of the plano-concave element;

r) a sequential combination of a plano-convex element and a plano-concave element with said convex side of said plano-convex element being adjacent to the essentially flat side of the plano-concave element;

s) a sequential combination of a plano-concave element with a plano-convex element with the essentially flat side of said plano-convex element being adjacent to the concave side of the of said plano-concave element;

t) including a miniscus lens; and

u) including an aspherical lense.

14. A lens system with application in ellipsometer and polarimeter systems as in Claim 1, wherein said converging element includes a selection from the group consisting of:

a positive miniscus;
an asymetric convex;

and wherein said diverging element includes a selection from the group consisting of:

a negative miniscus;
an asymetric concave.

15. A dual stage lens system with application in ellipsometer systems as in Claim 4, wherein each said converging element includes a selection from the group consisting of:

a positive miniscus;
an asymetic convex;

and wherein each said diverging element includes a selection from the group consisting of:

a negative miniscus;
an asymetric concave.

16. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements, said parameterized equations enabling, when parameters therein are properly evaluated, independent calculation of retardation entered by each of said input and said output optical elements between orthogonal components of a beam of electromagnetic radiation caused to pass through said input and output optical elements, at least one of said input and output optical elements being birefringent, said method comprising, in any functional order, the steps of:

a. providing spatially separated input and output optical elements, at least one of said input and output optical elements demonstrating birefringence when a beam of electromagnetic radiation is caused to pass therethrough, there being a means for supporting a material system positioned between said input and output optical elements;

b. positioning an ellipsometer system source of electromagnetic radiation and an ellipsometer system detector system such that in use a beam of electromagnetic radiation provided by said source of electromagnetic radiation is caused to pass through said input optical element, interact with said material system in a plane of incidence thereto, and exit through said output optical element and enter said detector system;

c. providing a material system to said means for supporting a material system, the composition of said material system being sufficiently well known so that retardance entered thereby to a polarized beam of electromagnetic radiation of a given wavelength, which is caused to interact with said material system in a plane of incidence thereto, can be accurately modeled mathematically by a parameterized equation which, when parameters therein are properly evaluated, allows calculation of retardance entered thereby between orthogonal components of a beam of electromagnetic radiation caused to interact therewith in a plane of incidence thereto;

d. providing a mathematical model for said ellipsometer system and said input and output optical elements and said material system, comprising separate parameterized equations for independently calculating retardance entered between orthogonal components of a beam of electromagnetic radiation caused to pass through each of said input and output optical elements and interact with said material system in a plane of incidence thereto; such that where parameters in said mathematical model are properly evaluated, retardance entered between orthogonal components of a beam of electromagnetic which passes through each of said input and output optical element and interacts with said material system in a plane of incidence thereto can be independently calculated from said parameterzed equations;

e. obtaining a spectroscopic set of ellipsometric data with said parameterizable material system present on the means for supporting a material system, utilizing a beam of electromagnetic radiation provided by said source of electromagnetic radiation, said beam of electromagnetic radiation being caused to pass through said input optical element, interact with said parameterizable material system in a plane of incidence thereto, and exit through said output optical element and enter said detector system;

f. by utilizing said mathematical model provided in step d. and said spectroscopic set of ellipsometric data obtained in step e., simultaneously evaluating parameters in said mathematical model parameterized equations for independently calculating retardance entered between orthogonal components in a beam of electromagnetic radiation caused to pass through said input optical element, interact with said material system in a plane of incidence thereto, and exit through said output optical element;

to the end that application of said parameterized equations for each of said input optical element, output optical element and material system for which values of parameters therein have been determined in step f., enables independent calculation of retardance entered between orthogonal components of a beam of electromagnetic radiation by each of said input and output optical elements, and said material system, at given wavelengths in said spectroscopic set of ellipsometric data, said calculated retardance values for each of said input optical element, output optical element and material system being essentially uncorrelated.

17. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claim 16, in which the step f. simultaneous evaluation of parameters in said mathematical model parameterized equations for said parameterizable material system, and for said input and output optical elements, is achieved by a square error reducing mathematical curve fitting procedure.

18. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claim 16, in which the step d. provision of a mathematical model for said ellipsometer system and said input and output optical

elements and said parameterizable material system, involves, for each of said input and output optical elements, providing separate parameterized mathematical model parameterized equations for retardance entered to each of said two orthogonal components of a beam of electromagnetic radiation caused to pass through said input and output optical elements; at least one of said orthogonal components for each of said input and output optical elements being directed out of the plane of incidence of said electromagnetic beam onto said parameterizable material system; such that calculation of retardation entered between orthogonal components of said beam of electromagnetic radiation, given wavelength, by said input optical element is provided by comparison of retardance entered to each of said orthogonal components for said input optical element, and such that calculation of retardation entered between orthogonal components of said beam of electromagnetic radiation, by said output optical element is provided by comparison of retardance entered to each of said orthogonal components for said output optical element.

19. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claim 16, in which the step f. simultaneous evaluation of parameters in said mathematical model parameterized equations for said parameterizable material system, and for said input and output optical element, is achieved by a square error reducing mathematical curve fitting procedure.

20. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claim 16, in which the step b. positioning of an ellipsometer system source of electromagnetic radiation and an ellipsometer system detector system includes positioning a polarizer between said source of electromagnetic radiation and said input optical

element, and the positioning of an analyzer between said output optical element and said detector system, and in which the step e. obtaining of a spectroscopic set of ellipsometric data involves obtaining data at a plurality of settings of at least one component selected from the group consisting of:

said analyzer; and
said polarizer.

21. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claim 18, in which the Claim 16 step b. positioning of an ellipsometer system source of electromagnetic radiation and an ellipsometer system detector system includes positioning a polarizer between said source of electromagnetic radiation and said input optical element, and the positioning of an analyzer between said output optical element and said detector system, and in which the step e. obtaining of a spectroscopic set of ellipsometric data involves obtaining data at a plurality of settings of at least one component selected from the group consisting of:

said analyzer; and
said polarizer.

22. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claim 16, in which the step of providing separate parameterized mathematical model parameterized equations for enabling independent calculation of retardance entered by said input said output optical elements between orthogonal components of a beam of electromagnetic radiation caused to pass through said input and output optical elements involve parameterized equations having a form selected from the group consisting of:

$$\text{ret}(\lambda) = (K1/\lambda)$$
$$\text{ret}(\lambda) = (K1/\lambda)*(1 + (K2/\lambda^2))$$
$$\text{ret}(\lambda) = (K1/\lambda)*(1 + (K2/\lambda^2) + (K3/\lambda^4))$$

23. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claim 18, in which the step of providing separate parameterized mathematical model parameterized equations for retardance entred to each of said two orthogonal components of a beam of electromagnetic radiation caused to pass through said input and output optical elements, for each of said input and output optical elements, thereby enabling independent calculation of retardance entered by said input entered by said output optical element between orthogonal components of a beam of electromagnetic radiation caused to pass through said input and output optical elements, involves, for each input and output optical element orthogonal retardation component and for said material system retardation, parameterized equations having a form selected from the group consisting of:

$$\text{ret}(\lambda) = (K1/\lambda)$$
$$\text{ret}(\lambda) = (K1/\lambda)*(1 + (K2/\lambda^2))$$
$$\text{ret}(\lambda) = (K1/\lambda)*(1 + (K2/\lambda^2) + (K3/\lambda^4))$$

24. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optial elements as in Claim 17, in which the Claim 16 step a. providing of spatially separated input and output optical element involves statically related grouping beam directing means with said input and output optical elements optionally including vacuum chamber windows.

25. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of

spatially separated input and output optical elements as in Claim 19, in which the Claim 16 step a. providing of spatially separated input and output optical elements involves grouping statically related beam directing means with said input and output optical elements, and optionally vacuum chamber windows.

26. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements, said parameterized equations enabling, when parameters therein are properly evaluated, independent calculation of retardation entered by each of said input optical element and said output optial element to at least one orthogonal component(s) of a beam of electromagnetic radiation caused to pass through said input and output optical elements, at least one of said input and output optical elements being birefringent, said method comprising, in any functional order, the steps of:

a. providing spatially separated input and output optical elements, at least one of said input and output optical elements demonstrating birefringence when a beam of electromagnetic radiation is caused to pass therethrough, there being a means for supporting a material system positioned between said input and output optical elements;

b. positioning an ellipsometer system source of electromagnetic radiation and an ellipsometer system detector system such that in use a beam of electromagnetic radiation provided by said source of electromagnetic radiation is caused to pass through said input optical element, interact with said material system in a plane of incidence thereto, and exit through said output optical element and enter said detector system;

c. providing a material system to said means for supporting a material system;

d. providing a mathematical model for said ellipsometer system and said input and output optical elements and said material system, comprising, for each of said input optical element and said output optical element, separate parameterized equations for retardance for at least one orthogonal component in a beam of electromagnetic radiation provided by said source of electromagnetic radiation, which orthogonal component is directed out of a plane of incidence which said electromagnetic beam makes with said material system in use, such that retardation entered to said out-of-plane orthogonal component can, for each of said input and output optical element, be separately calculated by said parameterized equations, given wavelength, where parameters in said parameterized equations are properly evaluated;

e. obtaining a spectroscopic set of ellipsometric data with said material system present on the means for supporting a material system, utilizing a beam of electromagnetic radiation provided by said source of electromagnetic radiation, said beam of electromagnetic radiation being caused to pass through said input optical element, interact with said material system in a plane of incidence thereto, and exit through said output optical element and enter said detector system;

f. by utilizing said mathematical model provided in step d. and said spectroscopic set of ellipsometric data obtained in step e., simultaneously evaluating material system DELTA'S in correlation with in-plane orthogonal component retardation entered to said beam of electromagnetic radiation by each of said input and output optical element, and parameters in said mathematical model parameterized equations for out-of-plane retardance entered by said input optical element and said output optical element to a beam of electromagnetic radiation caused to pass through said input optical element, interact with said material system in said plane of incidence thereto, and exit through said output optical element;

to the end that application of said parameterized equations for out-of-plane retardance entered by said input optical element and said output optical element to a beam of electromagnetic radiation caused to pass through said input optical element, interact with said material system in said plane of incidence thereto, and exit through said output optical element, for which values of parameters therein are determined in step f., enables independent calculation of retardance entered to said out-of-plane orthogonal component of a beam of electromagnetic radiation by each of said input and output optical element.

27. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical element as in Claim 26, in which the step f. simultaneous evaluation of parameters in said mathematical model parameterized equations for calculation of retardance entered to said out-of-plane orthogonal component of a beam of electromagnetic radiation by each of said input and output optical elements, and said correlated material system DELTA'S and retardance entered to said in-plane orthogonal component of a beam of electromagnetic radiation by each of said input and output optical elements, is achieved by a square error reducing mathematical curve fitting procedure.

28. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claim 26, which further comprises the steps of:

g. providing a parameterized equation for retardation entered by said material system to the in-plane orthogonal component of a beam of electromagnetic radiation, and as necessary similar parameterized equations for retardation entered by each of said input and output optical elements to the in-plane orthogonal component of a beam of electromagnetic radiation; and

h. by utilizing said parameterized mathematical model provided in step d. and said spectroscopic set of ellipsometric data obtained in step e., simultaneously evaluating parameters in said mathematical model parameterized equations for independent calculation of retardance entered in-plane by said material system and by said input optical element and said output optical element such that the correlation between material system DELTA'S and the retardance entered by said in-plane orthogonal component of a beam of electromagnetic radiation by each of said input and output optical elements, at given wavelengths in said spectroscopic set of ellipsometric data, is broken;

to the end that application of said parameterized equations for each of said input lens, output optical element and material system for which values of parameters therein have been determined in step h., enables independent calculation of retardance entered to both said out-of-plane and said in-plane orthogonal components of a beam of electromagnetic radiation by each of said input and output optical elements, and retardance entered by said material system to said in-plane orthogonal component of said beam of electromagnetic radiation, at given wavelengths in said spectroscopic set of ellipsometric data.

29. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claim 28, in which the step h. simultaneous evaluation of parameters in said mathematical model parameterized equations for said in-plane retardation entered by said parameterized material system, and said input and output optical elements, is achieved by a square error reducing mathematical curve fitting procedure.

30. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claim

26, which further comprises the steps of:

g. removing the material system from said means for supporting a material system positioned between said input and output optical elements, and positioning in its place an alternative material system for which a parameterized equation for calculating in-plane retardance entered to a beam of electromagnetic radiation, can be provided;

h. providing a parameterized equation for retardation entered in-plane to an orthogonal component of a beam of electromagnetic radiation by said alternative material system which is then positioned on said means for supporting a material system positioned between said input and output optical elements, and as necessary similar parameterized equations for retardation entered by each of said input and output optical elements to the in-plane orthogonal component of a beam of electromagnetic radiation;

i. obtaining a spectroscopic set of ellipsometric data with said alternative material system present on the means for supporting a material system, utilizing a beam of electromagnetic radiation provided by said source of electromagnetic radiation, said beam of electromagnetic radiation being caused to pass through said input lens, interact with said alternative material system in a plane of incidence thereto, and exit through said output optical element and enter said detector system;

j. by utilizing said parameterized mathematical model for said input optical element and said output optical element provided in step d. and said parameterized equation for retardation entered by said alternative material system provided in step h., and said spectroscopic set of ellipsometric data obtained in step i., simultaneously evaluating parameters in said mathematical model parameterized equations for independent calculation of retardance

entered to an in-plane orthogonal component of said beam of electromagnetic radiation by said alternative material system and by said input optical element and said output lens, such that correlation between DELTA'S entered by said alternative material system and retardance entered by said in-plane orthogonal component of said beam of electromagnetic radiation, by each of said input and output optical elements, at given wavelengths in said spectroscopic set of ellipsometric data, is broken, said simultaneous evaluation optionally providing new values for parameters in parameterized equations for calculation of retardance entered in said out-of-plane components of said beam of electromagnetic radiation by each of said input optical element and said output lens;

to the end that application of said parameterized equations for each of said input lens, output optical element and alternative material system, for each of which values of parameters therein have been determined in step j., enables independent calculation of retardance entered to both said out-of-plane and said in-plane orthogonal components of a beam of electromagnetic radiation by each of said input optical element and said output lens, and retardance entered by said alternative material system to said in-plane orthogonal component of a beam of electromagnetic radiation, at given wavelengths in said spectroscopic set of ellipsometric data.

31. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claim 30, in which the step j. simultaneous evaluation of parameters in said mathematical model parameterized equations for said in-plane retardation entered by said parameterized material system, and at least said in-plane input optical element and output lens, is achieved by a square error reducing mathematical curve fitting procedure.

32. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claim 26, in which the step b. positioning of an ellipsometer system source of electromagnetic radiation and an ellipsometer system detector system includes positioning a polarizer between said source of electromagnetic radiation and said input lens, and the positioning of an analyzer between said output optical element and said detector system, and in which the step e. obtaining of a spectroscopic set of ellipsometric data involves obtaining data at a plurality of settings of at least one component selected from the group consisting of:

said analyzer; and
said polarizer.

33. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claim 30, in which the Claim 26 step b. positioning of an ellipsometer system source of electromagnetic radiation and an ellipsometer system detector system includes positioning a polarizer between said source of electromagnetic radiation and said input lens, and the positioning of an analyzer between said output optical element and said detector system, and in which the step i. obtaining of a spectroscopic set of ellipsometric data involves obtaining data at a plurality of settings of at least one component selected from the group consisting of: (said analyzer and said polarizer).

34. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claim 26, in which the step of providing separate parameterized mathematical model parameterized equations for enabling

independent calculation of out-of-plane retardance entered by said input said output optical elements to said beam of electromagnetic radiation caused to pass through said input and output optical elements, involves parameterized equations having a form selected from the group consisting of:

$$\mathrm{ret}(\lambda) = (K1/\lambda)$$
$$\mathrm{ret}(\lambda) = (K1/\lambda)*(1 + (K2/\lambda^2))$$
$$\mathrm{ret}(\lambda) = (K1/\lambda)*(1 + (K2/\lambda^2) + (K3/\lambda^4))$$

35. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claim 34, in which the step of providing separate parameterized mathematical model parameterized equations for retardance entered to the out-of-plane and in-plane orthogonal components of a beam of electromagnetic radiation caused to pass through said input and output optical elements, thereby enabling independent calculation of out-of-plane and in-plane retardance entered by said input said output optical element to out-of-plane and in-plane orthogonal components of a beam of electromagnetic radiation caused to pass through said input and output optical elements, and the step of providing a parameterized equation for in-plane retardance entered by interaction of said beam of electromagnetic radiation with said material system involve, for each input and output optical element orthogonal retardation component parameterized equations having a form selected from the group consisting of:

$$\mathrm{ret}(\lambda) = (K1/\lambda)$$
$$\mathrm{ret}(\lambda) = (K1/\lambda)*(1 + (K2/\lambda^2))$$
$$\mathrm{ret}(\lambda) = (K1/\lambda)*(1 + (K2/\lambda^2) + (K3/\lambda^4))$$

36. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of

spatially separated input and output optical elements as in Claim 34, in which the step of providing separate mathematical model parameterized equations for retardance entered to the out-of-plane and in-plane orthogonal components of a beam of electromagnetic radiation caused to pass through said input and output optical elements, thereby enabling independent calculation of out-of-plane and in-plane retardance entered by said input said output optical element to out-of-plane and in-plane orthogonal components of a beam of electromagnetic radiation caused to pass through said input and output optical elements, and the step of providing a parameterized equation for in-plane retardance entered by interaction of said beam of electromagnetic radiation with said alternative material system involve, for each input and output optical element orthogonal retardation component parameterized equations having a form selected from the group consisting of:

$$ret(\lambda) = (K1/\lambda)$$
$$ret(\lambda) = (K1/\lambda)*(1 + (K2/\lambda^2))$$
$$ret(\lambda) = (K1/\lambda)*(1 + (K2/\lambda^2) + (K3/\lambda^4))$$

37. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claim 29, in which the Claim 26 step a. providing of spatially separated input and output optical elements involves grouping statically related beam directing means with said input and output optical elements, and optionally vacuum chamber windows.

38. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claim 31, in which the Claim 26 step a. providing of spatially separated input and output optical elements involves grouping statically related beam directing means with said input and

output optical elements, and optionally vacuum chamber windows.

39. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claim 16 or 26, which further involves, in a functional order:

fixing evaluated parameter values in mathematical model parameterized equations, for each of said input optical element and output lens, such that said parameterized equations allow independent determination of retardation entered between orthogonal components of a beam of electromagnetic radiation caused to pass through said input and output optical elements; and

causing an unknown material system to be present on said means for supporting a material system;

obtaining a spectroscopic set of ellipsometric data with said unknown material system present on the means for supporting a material system, utilizing a beam of electromagnetic radiation provided by said source of electromagnetic radiation, said beam of electromagnetic radiation being caused to pass through said input lens, interact with said alternative material system in a plane of incidence thereto, and exit through said output optical element and enter said detector system; and

by utilizing said mathematical model for said input optical element and said output optical element in which parameter values in mathematical model parameterized equations, for each of said input optical element and output optical element have been fixed, simultaneously evaluating PSI'S and uncorrelated DELTA'S parameters for said unknown material system.

40. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claims 37, in which said simultaneous evaluation of PSI'S and DELTA'S for said unknown material are achieved by a square error reducing mathematical curve fitting procedure.

41. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claims 16 or 26, in which the step of providing spatially separated input and output optical elements, at least one of said input and output optical elements demonstrating birefringent when a beam of electromagnetic radiation is caused to pass therethrough, involves one optical element which is not significantly birefringent.

42. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claims 16 or 26 or 41, in which at least one optical element is not significantly birefringent is selected from the group consisting of:

essentially a surrounding ambient; and

a multi-element lens.

43. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claim 16 or 26, in which the step b. positioning of an ellipsometer system source of electromagnetic radiation and an ellipsometer system detector system includes positioning additional elements between said source of electromagnetic radiation and said input

lens, and/or between said output optical element and said detector system, and in which the step e. obtaining of a spectroscopic set of ellipsometric data involves obtaining data at a plurality of settings of at least one of said additional components.

44. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claims 16 or 26, which further involves, in a functional order:

fixing evaluated parameter values in mathematical model parameterized equations, for each of said input optical element and output lens, such that said parameterized equations allow independent determination of retardation entered between orthogonal components of a beam of electromagnetic radiation caused to pass through said input and output optical elements; and

causing an unknown material system to be present on said means for supporting a material system;

obtaining a spectroscopic set of ellipsometric data with said unknown material system present on the means for supporting a material system, utilizing a beam of electromagnetic radiation provided by said source of electromagnetic radiation, said beam of electromagnetic radiation being caused to pass through said input lens, interact with said alternative material system in a plane of incidence thereto, and exit through said output optical element and enter said detector system; and

by utilizing said mathematical model for said input optical element and said output optical element in which parameter values in mathematical model parameterized equations, for each of said input optical element and output optical element have been fixed,

simultaneously evaluating ALPHA'S and BETA'S for said unknown material system;

applying transfer functions to said simultaneously evaluated ALPHA'S and BETA'S for said unknown material system to the end that a data set of effective PSI's and DELTA's for a combination of said optical elements and said material system is provided;

providing a mathematical model for said combination of said input and said output optical elements and said material system which separately accounts for the retardation effects of the presence of said input and said output optical elements and said material system by parameterized equations; and

by utilizing said mathematical model for said combination of said optical elements and said material system which separately accounts for the effects of the presence of at least said input and output optical elements by parameterized equations; and said data set of effective PSI's and DELTA's for a combination of said input and output optical elements and said material system, simultaneously evaluating actual PSI's and DELTA's for said unknown material system per se.

45. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of spatially separated input and output optical elements as in Claim 44 in which the step of providing a mathematical model for said combination of said input and output optical elements and said material system which separately accounts for the retardation effects of the presence of said input and output optical elements and said material system by parameterized equations which further includes providing for the effects of handedness.

46. A method of accurately evaluating parameters in parameterized equations in a mathematical model of a system of

spatially separated input and output optical elements as in Claims 44 or 45, in which said evaluation of actual PSI's and DELTA's is achieved by a square error reducing mathematical curve fitting procedure.

add (8)